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Vol. 43 No. 3

BULLETIN

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TORREY BOTANICAL CLUB

MARCH, 1916

The morphology of Thallocarpus Curtisii

F. McALLISTER

(WITH PLATE 4)

The first published description of *Thallocarpus Curtisii* (Aust.) Lindb. seems to have been by Austin in 1869 (1). The simple structure of its sporogonium, which is without foot or elaters, naturally pointed toward a relationship to *Riccia*. In the dried material from which his descriptions were made the thallus appeared very like that of *Sphaerocarpos*. This, together with the fact of the spores adhering in fours, led him to believe that it must also be related to *Sphaerocarpos*. He believed it to be a genus intermediate between *Riccia* and *Sphaerocarpos* and gave it the name *Cryptocarpus*, the only species being *C. Curtisii*. The following is his description of genus and species:

"CRYPTOCARPUS (gen. nov.) Aust. MSS., 1864.

"Frons laxe spongioso-reticulata, irregulariter subpalmatim lobata, tenuis, epidermide hand distincta. Costa nulla. Radices intus non papillosi (ut in *Sphaerocarpo*), longissimi, intertexti. Fructus in frondis substantia immersus (ut in *Riccia*). Sporangia depresso-globosa, singulatim nata, non libera. Calyptra stylo nigro persistente coronata. Sporae 4-jugae (ut in *Sphaerocarpo*), vix solutae, in aspectu singulae et profunde quadrilobae."

"CRYPTOCARPUS CURTISII Aust. MSS. 1864.

"*Riccia Curtisii*, James, in Herb. (fide Curtis).

"Fronde caespitosa valde imbricata fibroso-papulata, laciniis inciso-lobulatis margine crenatis; sporangiis maximis in statu siccati latentibus sed frondes hume-

[The BULLETIN for January (43: 63–116. *pl. 1–3*) was issued March 11, 1916.]

actae sunt in substantia earum ut maculis nigris apparentibus; sporis fusco-nigris valde muricatis.

"On moist ground, South Carolina, Ravenel (In Herb. Sulliv., 1849). North Carolina, Curtis (l. c., 1853). 'Montand après Marseille' (Herb. Lanning, 'ex Herb. Torrey')."

Somewhat later (**10**) Lindberg called attention to the fact that the generic name *Cryptocarpus* was already in use, being used as the name of a genus of the Chenopodiaceae as well as for a genus in the Orthotrichiaceae. He proposed the name *Thallocarpus*, which is still in use. He makes no mention of having examined any plants and apparently on the authority of Austin's description places the genus in the Jungermanniaceae, class Cleistocarpae.

In 1877 Trevisan (**14**) proposed the name *Angiocarpus* as a substitute for *Cryptocarpus*. He placed the genus in the order Ricciaceae, tribe Riccieae, with *Ricciella*, *Riccia* and *Ricciocarpus*.

Austin in 1875 (**2**) referring to Lindberg's change of the generic name to *Thallocarpus** states that "the plant evidently belongs, with *Sphaerocarpus* (its nearest ally), to the Jungermaniaceae."

Later he refers again to *Thallocarpus* (**3**) having in the meantime studied fresh living material collected for him by Capt. John Donnell Smith in Florida. From this material he notes the striking similarity to *Riccia* "in which genus" he says "it should probably be included as a subgenus." He states that the adhesion of the spores of the tetrad "appears to be the only character in which it is decidedly different from *Riccia*." It is from this material that he determines the dioecious character of the liverwort.

This seems to be the literature that Schiffner has had access to in his account of *Thallocarpus* in Die natürlichen Pflanzenfamilien (**11**, p. 50). It is therefore surprising to find that Austin's latest reference to the plant has been overlooked or ignored and this genus placed in the subclass Jungermanniales and family Sphaerocarpoideae; in a family, the sporophyte of which is characterized by the presence of a foot and of sterile, "stärkereiche Nährzellen."

* Although Lindberg proposed the name *Thallocarpus* he does not seem to have suggested the combination *T. Curtisii*. Austin makes use of this combination in 1875 but does not cite Lindberg as authority.

Stephani (12), under the name *Riccia Curtisii*, has elaborated the description of *Thallocarpus* from material "welche Pastor Curtis in seinem Garten gesammelt hat." He asserts that the plants which he examined were monoecious. In other respects his description does not seem to diverge in any important detail from that of Austin. He, however, insists that material from Austin's herbarium in the possession of Pearson corresponds fully with his description.

Thallocarpus is of common occurrence in the vicinity of Austin, Texas, during late winter and spring, growing most abundantly in sandy soil along with Riccias, *Sphaerocarpos*, and other liverworts. The plant studied corresponds very closely with those described by Austin if we take into account the essential corrections made in his later references to the liverwort. There seems little doubt that it should be regarded as the same species.

Because of the disagreement of Austin and Stephani as to the sex of the thallus of *Thallocarpus* I have examined a large number of thalli with this point in mind. Although a large number of plants of both sexes and of all ages were carefully dissected under a binocular microscope I was unable to find both archegonia and antheridia on any of the plants examined. Realizing the difficulty of detecting and recognizing immature sex organs in dissected material I have carefully examined paraffin sections of about fifty thalli, most of which were female. Part of these plants were sectioned to obtain material for a study of the morphology of the thallus and sporophyte, but special care was taken in each case to mount and stain the entire thallus. No case of the monoecious condition has been found in this material. The evidence seems fairly conclusive that *Thallocarpus*, as it occurs in the vicinity of Austin, is strictly dioecious.

I have accumulated considerable evidence to show that the four spores of the spore ball of *Thallocarpus* give rise to two female plants and two male plants as has been shown to be the case in *Sphaerocarpos texanus* Aust. (*S. californicus* Aust.) (13). I shall, in the near future, publish my results on this phase of the life history of *Thallocarpus*.

Material for this study was collected during the months of March, April, and May of the years 1914 and 1915. Weak

Flemming's solution gave perhaps the most successful fixation though there was no marked difference in the action of the killing solutions used. The gelatinous material of the older sporophytes interfered greatly with the penetration of the reagents, though an air pump was used to hasten the penetration of the liquids.

The thallus of *Thallocarpus* varies greatly in size. Mature sporophytes may be found in thalli with a diameter of but two millimeters, while in late spring sterile thalli may be found which have a diameter as great as fifteen millimeters. The male plants rarely exceed three or four millimeters in diameter, the average diameter being less than three millimeters.

When very young the thallus is distinctly bilobed, having a single distinct growing area. The mature male plants are usually bilobed only. The female thalli usually become symmetrically four-lobed but later the lobing becomes less regular and in the larger thalli there is often a suggestion of palmate lobing with the lobes often crowded and overlapping.

The thallus is very spongy in texture, resembling in this respect the spongy Riccias. Many irregular openings are visible in the upper surface. As is the case with the spongy Riccias the thallus is pale green in color. Superficially it resembles *Riccia crystallina* L.

Cross sections of the thallus show it to be made up, in the upper part of the thallus, of irregular plates of cells, mostly a single layer in thickness. At the upper surface these plates are broadened greatly to form the upper "epidermis" (FIG. 1). The tissue at the base of the thallus is compact with but few intercellular spaces.

The archegonia begin development at the surface of the thallus just back of the growing point. The mother cell of the archegonium elongates and divides transversely, the upper cell being the smaller (FIG. 2). The lower cell divides again by a transverse wall (FIG. 3) which according to Campbell (**6**) also occurs in the development of the archegonium of *Sphaerocarpos* while in *Riccia* this cell remains undivided. The divisions of the upper cell seem to be the same as in *Riccia*. The general structure of the mature archegonium does not present anything new. The neck canal cells seem to number four or five (FIGS. 4, 5).

As the archegonia develop, plates of cells are formed about them in such a manner as to entirely submerge them at maturity.

The antheridia arise back of the growing point of the male thallus in much the same position as the archegonium appears in the female plant. I have not followed the development of the antheridium in detail but there seems to be no noteworthy difference between them and those of *Riccia*. From FIGS. 6 and 7 it will be seen that the early stages of development conform entirely with those of *Riccia*, according to the accounts of Garber, Campbell, and Lewis.

The fertilized egg divides by a wall transverse to the long axis of the archegonium (FIG. 8) as is the case with *Riccia* and the other Marchantiales. The subsequent divisions seem also to be the same as in *Riccia*, forming finally a sphere eight to ten cells across at the longest diameter. Divisions cease in the mass of sporophytic cells when the sporogonium is about half grown (FIG. 10). At this period the cells are all alike, no difference being observable between the cells that are later to form the wall and those that are to form the spore mother cells.

Frequently, however, a number of sporophytic cells adjoining the neck canal, fix and stain differently from the rest of the cells of the sporophyte. They are usually smaller cells with denser protoplasmic content and with nuclei which are smaller and which take the stain more readily than those of the other cells of the sporophyte. From FIGS. 9, 10, 11, and 12 it will be seen that they occur in sporophytes of all ages, except possibly those fully mature. Miss Black (**5**) has observed bacteria accumulated at the base of the neck canal in *Riccia Frostii* Aust., causing injury to the sporophytic cells of this region. It is possible that the above mentioned cells of the sporophyte of *Thallocarpus* may have been injured by secretions of bacterial origin though I have never observed bacteria-like structures in this region.

The single layer of cells of the venter divides early to form two layers (FIG. 9). These cells enlarge with the division and enlargement of the cells of the sporophyte but do not themselves undergo further division. Their dimensions at the maturity of the sporophyte are at least three times as great as at first (FIGS. 12, 13). The outer layer of venter cells is seen early to be abund-

antly supplied with chloroplasts while the inner layer lacks them (FIGS. 11, 12). As the spores mature the inner of the two layers of venter cells is crushed and absorbed while the outer layer remains intact, forming a persistent layer about the mass of spores (FIG. 14).

The cells of the sporophyte are probably more than half grown before any difference is perceptible between the cells of the amphithecium and the sporogenous cells (FIG. 9). This difference is first seen in a decrease of the protoplasmic content of the peripheral cells, and a possible increase in the density of the protoplasm of the sporogenous cells (FIG. 10). Later, as the sporogenous cells continue to enlarge, a difference in the size of the cells is apparent. At the time of the rounding up of the spore mother cells before division, the cells of the peripheral layer have a very scanty protoplasmic content and small, degenerate nuclei. The cells are however plump and distended with cell sap and do not show signs of collapse till much later (FIG. 12). Their collapse and disintegration at a later stage greatly enlarges the cavity in which the spores lie (FIG. 13).

Beer (**4**) has observed similar, large, vacuolate cells making up the amphithecium of *Riccia glauca* L. Garber (**7**), Campbell (**6**), and Lewis (**9**) have, however, described the amphithecium of *Riccia* as made up of flat cells which have dense contents.

The rounding up of the spore mother cells previous to the reduction divisions is accompanied by a swelling and gelatinization of the cell walls (FIG. 12). The gelatinous material accumulates in the spaces between the now rounded spore mother cells (FIG. 13) where it interferes greatly with the penetration of the killing solutions. In fixed material it stains deeply with the violet stain. Garber and Lewis have both observed such gelatinous accumulations in *Riccia* and are of the opinion that it is food material, derived, in part at least, from the surrounding cells, which are believed to be abundantly supplied with food material. In *Thallocarpus* this is not the case. No excess of food is to be identified in the surrounding cells nor is there any marked change in these cells upon the appearance of the gelatinous material. The gelatinization of the walls of the spore mother cells together with the disintegration of the wall layer of cells seems sufficient to account for the amount of gelatin formed.

The gelatinous material persists for some time, disappearing only as the thick common wall is formed around the spore tetrad (FIG. 14). The sporogenous cells all round up to form spore mother cells and all of the spore mother cells undergo division and all of the resulting cells form spores. None become sterile nutritive cells nor elater-like cells.

After the division of the spore mother cell the resulting cells become separated by a thin wall but remain closely attached and finally become surrounded by a thick, papillate common wall (FIGS. 14, 15). These spore walls remain thin and undeveloped until the thick retaining wall of the spore ball is completely formed (FIG. 14). The outer face of the tetrahedral spore is slightly roughened with projections which in cross section appear crenulate (FIG. 16). While thickened to a marked degree the wall of this outer face is not more than half as thick as the retaining wall of the spores of the tetrad. The inner faces of the spore are thickened only slightly.

It will be seen from the above that the structure and the development of the gametophyte and the sporophyte of *Thallocarpus* is practically identical with that of *Riccia*. The adhesion of the spores of the tetrad in a spore ball and the lack of peg-like thickenings in the rhizoids of the former are the only characters upon which a separation of the two genera could be based.

The morphology of the plant is nevertheless that of a *Riccia* rather than of a *Sphaerocarpos*. The adhesion of the spores is certainly very scanty evidence upon which to base relationship to the latter genus, for not all of the *Sphaerocarpos* species have spores remaining attached at the time of their shedding. The spores of *S. cristatus* M. A. Howe separate long before maturity and those of *S. Donellii* Aust. separate as they come to maturity (**8**).

The occurrence of peg-like rhizoid thickenings throughout the Marchantiales and their lack in the Jungermanniales may be a character of greater phylogenetic significance. While it is probable that this character should receive more consideration than the spore characters, nevertheless, in view of the essential identity of the structure of the gametophyte of *Thallocarpus* with that of *Riccia*, it would seem extreme to remove the genus *Thallocarpus* from the Marchantiales on the grounds of this character alone.

The monoecious plants which Stephani believed he had found may possibly be explained on the ground of the small size of the male plants and the crowded growth of the thalli, which become attached in masses by the rhizoids. The male plants cease growing early and are often entirely overgrown by the female plants. In dry material it would be difficult to separate the plants or even to identify any organic separation. This is often difficult in living material collected early in the season. Two cases of what seemed at first to be monoecious plants in paraffin sections turned out to be distinct plants, the male plant being entirely covered by the female plant. There seems little doubt that the Texas *Thallocarpus*, at least, is dioecious.

SUMMARY

1. *Thallocarpus*, as it occurs in the vicinity of Austin, Texas, seems to be strictly dioecious.

2. The spores of the tetrad adhere after shedding and give upon germination two male and two female plants.

3. The structure of the thallus and the sporophyte is identical with that of the Riccias with the exception of the adhering spore tetrads and the pegless rhizoids.

4. The above mentioned structural differences seem insufficient to exclude *Thallocarpus* from the Marchantiales.

I am indebted to Mr. F. C. Werkenthin, of State College, New Mexico, for valuable aid in preparing sections for this study.

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AUSTIN, TEXAS

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Explanation of plate 4

The magnification of the figures is about 250 diameters, with the exception of FIG. 1, which is magnified about 30 diameters.

FIG. 1. A portion of a section of a thallus, showing a sporophyte, nearly mature.

FIGS. 2, 3. Early stages in the development of the archegonium.

FIG. 4. Archegonium, not quite mature, becoming submerged by outgrowths of the thallus.

FIG. 5. Archegonium after fertilization of the egg.

FIGS. 6, 7. Early stages in the development of the antheridium.

FIG. 8. A four-celled embryo sporophyte.

FIG. 9. A later stage in the development of the embryo. Venter wall two cell layers in thickness. A group of cells at the apex of the sporophyte separated from the main mass.

FIG. 10. Embryo about half grown. No distinction visible between the peripheral cells and the inner cells of the sporophyte.

FIG. 11. Peripheral cells of sporophyte now easily identified by their scanty protoplasmic content.

FIG. 12. Gelatinization of the cell walls and the rounding up of the spore mother cells. Cells of the amphithecium still plump and intact.

FIG. 13. Spore mother cells fully rounded up and surrounded by the homogeneous gelatinous material. Peripheral layer of cells disintegrated. Venter cells still intact.

FIG. 14. Spores approaching maturity. The papillate retaining wall of the spore ball nearly mature. The spore walls still thin.

FIG. 15. One spore and part of the common retaining wall.

FIG. 16. Section of nearly mature spore, pulled away from spore ball by sectioning knife.

Morphology of the flowers of Zea Mays

PAUL WEATHERWAX

(WITH PLATES 5 AND 6 AND FOUR TEXT FIGURES)

The structure of the maize plant presents a series of problems of a very special nature. Many of these have been thoroughly worked out from a purely morphological point of view, but it need hardly be said that the mass of economic information about corn almost obscures the part that may be considered purely botanical. Of the special morphology of the plant probably no part has received less thorough treatment, in proportion to its importance, than that pertaining to its floral parts. It is true that many studies have dealt in a way with this phase of the subject, but it has almost always been in connection with some more extended study and has, consequently, been superficially treated. The result is that one looks in vain through botanical literature for a complete and well-illustrated discussion of the structure of the maize flower.

The investigations upon which this work is based have extended over a period of almost two years, during which time representatives of all the six subspecies of *Zea Mays* have been under observation to a greater or less extent. The greater part of the work has been done upon different varieties of sweet corn, but the other five types have also been examined, especially where any variation from the sweet corn type of flower was apparent. All the available literature has been consulted, and most of the points made therein have been verified.

It is not intended here to present a group of facts that are entirely new. The available data, widely scattered, have been collected, and some changes and additions have been made, together with an attempt to illustrate fully wherever an illustration will emphasize a point or convey the meaning more clearly.

I desire to express my obligations to Professor D. M. Mottier for valuable suggestions and criticisms pertaining to this work,

and to a number of friends who have supplied me with seed of some of the varieties of corn used.

INFLORESCENCE

In the typical case the male and female inflorescences are borne on separate parts of the same maize plant, the former being the tassel and the latter the forerunner of the ear. Exceptions to this separation of the two types of flower sometimes occur and will be discussed later.

The male inflorescence is a broadly expanded panicle, often more than a foot in length, and made up of a central axis and several spreading rachids. Upon each rachis and the central axis the spikelets are arranged in pairs or, more rarely, in groups of three or four; one spikelet of each group is usually pedicelled, while the others are sessile.

The female inflorescence is a thickened spike, later to develop into the ear with its woody cob. Upon the axis of this inflorescence are borne a number of double rows of spikelets, the rows being double because of the pairing of the spikelets, and from these are produced an even number of rows of grains. Normally the minimum number of rows is eight, and it may vary in even numbers from this to twenty-four or more. The whole female inflorescence is enclosed in the husks, which are modified leaf sheaths borne upon the short branch that bears the ear.

It is very probable that the ear has developed from a primitive bisexual inflorescence, which had a structure similar to that of the male inflorescence of the plant at the present time; but Harshberger (1) and Montgomery (2), who have made extensive studies of this, disagree as to how this step actually took place, the one holding that the rachids of the primitive inflorescence united to form the ear, and the other maintaining that it was only the central spike of the tassel that persisted. Good arguments are found to support each view, and some other evidences not mentioned by either of the above, but having an important bearing upon the question, are now under observation and will be made the subject of a future report.

The normal male inflorescence of the plant at the present time is generally believed to have resulted from the suppression of the pistils of the hermaphrodite flowers of the primitive inflorescence.

STAMINATE FLOWER

The male spikelet contains, either functional or in rudimentary form, all the parts of the typical grass spikelet. It is normally two-flowered. A few one-flowered spikelets have been observed, but they usually contain a second flower in an undeveloped condition. At the ends of rachids, spikelets with more than two flowers are sometimes found, but they are probably to be understood as being two or more two-flowered spikelets combined.

Completely enclosing the rest of the spikelet before maturity are the two rather firm, taper-pointed, empty glumes, having a varying number of nerves and thickly beset, as is the rachilla below the glumes, with short, stiff bristles. The lower glume overlaps the edges of the upper and has the lower point of insertion upon the rachilla (FIG. 1). The flower is in the axis of the thin, membranaceous, blunt-pointed, two- to four-nerved lemma or flowering glume, and subtended by the palea, which has a similar structure except that it is regularly two-nerved. No trace of a continuation of the rachilla has been observed between the paleae. On this basis, then, there is no indication that the normal spikelet was ever more than two-flowered. The rachilla is jointed just below the glumes.

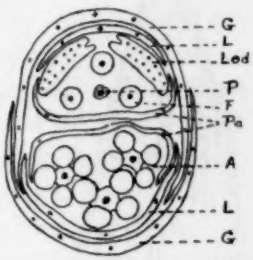

FIG. 1. Transverse section of lower part of staminate spikelet of Country Gentleman sweet corn, ×20. *G*, glumes; *Lod*, lodicule; *F*, filament of a stamen; *A*, anther; *L*, lemma; *P*, rudimentary pistil; *Pa*, palea.

In so far as was observed, the two flowers are identical in structure, but the upper one is the first to mature. During microspore development the anthers of the upper flower are often found with the tetrad stage or with the pollen grains rounded off, while those of the lower flower show resting or synaptic stages; but the pollen grains of the younger flowers are usually rounded off and apparently mature before the older flower puts out its stamens.

The three stamens of each flower are so arranged that their points of attachment form the vertices of a triangle which has one of its bases toward the palea. Midway between the two lateral stamens is the rudiment of a pistil. Next to the lemma,

and outside the triangular area to which the stamens and rudimentary pistil are attached, are the lodicules (FIG. 2 and TEXT FIG. 1).

The immature stamens have short, stiff, and rather fleshy filaments, which become long, thin, and flexible in anthesis, allowing the anthers to hang well below the rest of the spikelet (compare FIG. 1 with FIG. 2 and with TEXT FIG. 2). The arrangement of the stamens in the flower seems to have nothing to do with the position that they will occupy in anthesis, all three sometimes falling from one side of the spikelet, or two from one side and one from the other as determined by external conditions. The immature anther has four loculi, which later form two "cells." The anther cells open by short slits and allow the pollen to sift out (FIG. 1).

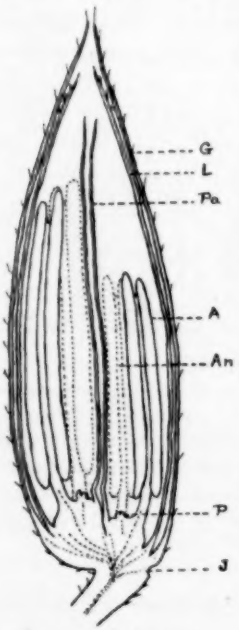

FIG. 2. Longitudinal section of staminate spikelet of Country Gentleman sweet corn, ×15. *G*, glume; *Pa*, palea; *An*, position of one of the lateral anthers; *L*, lemma; *A*, dorsal anther; *P*, rudimentary pistil; *J*, joint of rachilla.

The thick, fleshy lodicules do not show the scale-like structure that often characterizes them in other grasses. Along the top of each there is a deep, rounded groove with irregular sides. The lodicule is well supplied with vascular tissue, transverse sections showing ten or twelve relatively large, well-distributed strands (TEXT FIG. 1). As the flower matures, the lodicules increase in size and push back the lemma and glume, thus opening the spikelet.

In the literature examined, the only mention of a pistil in a male flower is by Baillon (**4**, p. 325) and Bentham and Hooker (**5**, p. 1114), both of whom, however, say that it is not present. They treat the normal flower as being wholly staminate in structure as well as in function; but the rudimentary pistil, a very inconspicuous body, to be sure, has been found in every staminate flower that I have examined. Its development has not yet been worked out; but it is known that long before anthesis its growth stops, and, during the greater

part of the development of the rest of the flower, the pistil shows evidences of disorganization, especially by its manner of taking stains.

The vascular system of the base of the spikelet has not been thoroughly worked out, but strands have been traced to most of the organs, including a large one to each lodicule and a rudimentary one to the abortive pistil.

PISTILLATE FLOWER

The available descriptions of the female spikelet and flower are much better than those of the homologous parts of the male inflorescence. This is largely due to the fact that several investigators have, in dealing with embryological features, found it necessary to discuss the developing caryopsis in relation to the other parts of the spikelet. However, since much of the work on the structure of the spikelet and flower has been merely incidental to other lines of investigation, many inaccuracies have found their way into the recent works.

The pistillate spikelet is two-flowered, and its parts are, in number and arrangement, similar to those of the staminate spikelet, allowing, of course, for the functioning of a pistil instead of stamens and the abortion of certain other parts.

The empty glumes are rather thick and fleshy and do not completely enclose the other parts, except in pod corn, at any time during the development of the spikelet. The hairs that are present on the glumes of the male spikelet are here represented by similar ones around the edges and by pits scattered over the surface of the glumes. The rachilla is jointed just below the base of the glumes (FIG. 3). The lemma and palea are shorter and thinner than the glumes. These floral bracts cease to develop, in most varieties, about the time of fertilization and remain around the base of the fruit, forming the red or white more or less chaffy covering of the cob. If fertilization is prevented, they may grow to three or four times their normal size. In the pod corns the floral bracts, especially the glumes, become herbaceous and continue to grow after fertilization and are ultimately found completely enclosing the mature fruit.

In most varieties of maize the two flowers of the female

spikelet are quite different in function and detailed structure, the lower one being aborted; and the descriptions of the two must be dealt with separately. There are certain important exceptions, however, to this peculiarity of the lower flower, and these will be discussed later.

The functional pistil occupies a normal position between the lemma and palea of the upper flower (TEXT FIG. 3). It is readily

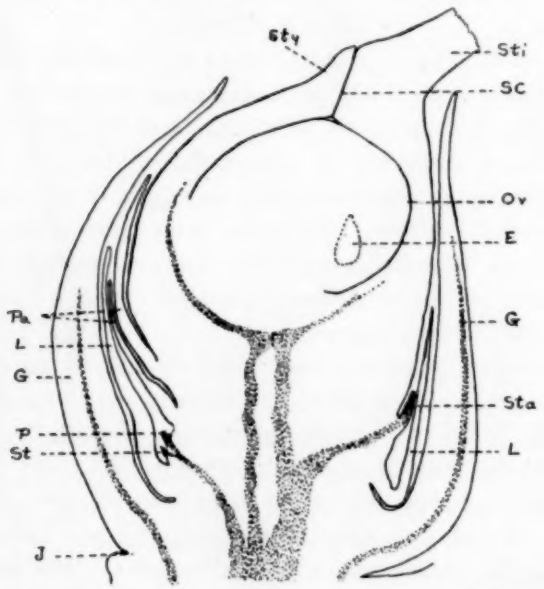

FIG. 3. Longitudinal section of pistillate spikelet of Black Mexican sweet corn, × 25. *Sti*, base of stigma; *Sty*, style; *E*, outline of embryo sac; *L*, lemma; *Pa*, palea; *St*, stamen of aborted flower; *SC*, stylar canal; *Ov*, functional ovule; *G*, glume; *Sta*, rudimentary stamen; *P*, pistil of aborted flower; *J*, joint of rachilla.

seen to consist of two parts, the bulb-shaped lower part, later developing into the caryopsis, and the long "silk" extending beyond the husks.

The accurate naming of at least one part of the pistil seems to have received little attention from recent writers. Harshberger (1, p. 400) speaks of the silk as a long, hairy style, and later adds that the style is hairy to entrap the round, smooth pollen grains. Hunt (6, p. 146) speaks of it as the "style, commonly known as the 'silk.' " Baillon (4, p. 325) and Bentham and Hooker (5, p. 1114)

give similar descriptions and call the silk a style. Only one dissenting opinion has thus far been noted, and that in Wood's (**7**) text-book, published about 1870. Here (p. 48) he figures the pistil of *Zea* and mentions its long, filamentous *stigma*.

All evidences indicate that the silk is stigmatic, at least in a rudimentary way, even to its base. The hairs are most numerous near the tip but are to be found all along the organ. Crozier (**8**) has noted that silks that have been repeatedly cut off are still capable of being pollenized, showing that it is not the forked tip alone that is stigmatic. Of course the part of the silk that is protected by the husks does not, under ordinary conditions, become a germinating place for pollen, but continued growth is always exposing parts that were previously covered. How long this might continue is not limited by any visible structural difference, and it is probable that pollen will germinate on any part of the silk. Even those who persistently call it a style admit that the silk catches the pollen grains and furnishes them a place to germinate, and this is by definition the function of a stigma. In cross section the silk has the shape of an asymmetrical figure eight (FIG. 8). This appearance is due to a longitudinal groove extending along both the adaxial and abaxial sides. The abaxial groove is deep and narrow, and the one on the adaxial side is broad and shallow (FIGS. 6–8). Near the tip these two grooves unite, making the silk unequally two-pointed (FIG. 5). A strand of vascular tissue traverses each side of the silk and continues into the tip after the silk divides. In distribution the hairs are limited to the edges and adaxial side (FIGS. 6–8), being more numerous, as has been said, near the distal extremity of the silk. If the two stigmas of the typical grass flower should unite for almost their entire length, the organ formed would be, except for relative length, not unlike a corn silk. It seems wholly consistent, therefore, to consider the corn silk a compound stigma.

Just what course the pollen tube takes with reference to the parts of the pistil is not definitely known, but growth of the tube causes the stigma to dry up. Silks that have been protected from pollen may, however, as Crozier (**8**) has pointed out, remain fresh for many days and continue to grow in length.

If the silk is to be considered a stigma, then the style is the

short protuberance at the top of the ovary, to one side of which the stigma is attached (FIGS. 3 and 4 and TEXT FIG. 3). The style is traversed by a tubular opening leading from the surface to the interior of the ovary (FIGS. 3 and 4 and TEXT FIG. 3.) This canal is especially prominent in young stages of ovarian development and never quite disappears. It has been termed the stylar canal by practically all that have had occasion to mention it, even by some of those that call the silk a style. Whether or not the pollen tube traverses this canal on its way to the ovule has not been determined.

The ovary is thick-walled and contains a single large, anatropous ovule. The embryo-sac is near the upper side, with reference to the cob as an axis, and the embryo is developed on that side of the caryopsis. The detailed structure and development of the ovary properly belongs in another connection and has been worked out by True (**9**, p. 212), Poindexter (**11**, p. 3), Guignard (**10**, p. 2), and others.

Just below the ovary, and somewhat irregularly spaced around the circumference of its support, are three small, rudimentary stamens (FIG. 4 and TEXT FIG. 3). They have a yellowish, wrinkled appearance and stain like disorganizing tissue. Baillon (**4**, p. 325) makes mention of "stamina 3 (in flore foemineo ad staminodia vix conspicua reducta," but Bentham and Hooker (**5**, p. 1114) dismiss the question with "staminodia 0." The other works that I have examined make no mention of these rudimentary stamens.

In the normally functional flower of the female spikelet the lodicules are, in so far as I have observed, entirely lacking. Montgomery (**2**, p. 61) has noted the same fact.

The aborted flower is much more simple in structure than the functional one just described. It is located between the lower lemma and palea, and, because of the suppressed development of its basal parts, it appears to be on the side of the pedicel that supports the functional flower (FIG. 4). In other words, the functional flower appears to terminate the rachilla, while the aborted one seems to be laterally attached; but there is no real evidence that either flower is morphologically at the end of the rachilla.

The male and female parts of this aborted flower make about equal development, the stamens being about as well developed as those of the functional female flower, and the pistil resembling that in the normal male flower. The lodicules are also present and pretty well developed (FIG. 9).

Sturtevant (**12**) reports that he found on one occasion an ear of pod corn that had the kernels "twinned in the pods." In several ears grown from seed furnished by Professor M. L. Fisher, of Purdue University, I have found a few pods each of which had two grains (FIG. 12). Examination of these shows that both flowers of a spikelet have developed. Kempton (**14**, pp. 8 and 9) reports the same occurrence in a few spikelets of a variety of corn grown by the Hopi Indians of Arizona and adds that the lower flower in several varieties occasionally develops, sometimes accompanied by the abortion of the upper flower. In the summer of 1914, while preparing material for study, I found that the variety of sweet corn known as Country Gentleman regularly has both flowers of the female spikelet functional. Stewart (**13**) has recently reported an observation of the same kind.

In this variety, then, two grains are produced where there is only one in most other varieties, and the ear has practically the double number of grains. On account of this the grains are so much crowded that they become long and slender (FIG. 13) and are thrown out of line so as to appear to be no longer arranged in rows (FIG. 14). Kempton (**14**, p. 8) speaks of one variety of sweet corn that shows an exception to the usual rowed arrangement of the grains, but he attributes the irregularity to an indiscriminate arrangement of the spikelets. The variety is not named, but, even to the "shoe peg" type of grain produced, it might be "Country Gentleman," except for the arrangement of the spikelets. I have found no variety of corn in which the spikelets were not arranged in rows on the cob.

In appearance and structure this functional lower flower of "Country Gentleman" sweet corn is similar to the upper one, but it is often somewhat smaller and slower to mature (TEXT FIG. 4). With reference to their position on the cob as an axis, the arrangement of the parts of this flower is, as might be expected, the exact opposite of that of the upper flower. This causes the stigma to

make a sharp bend near its base in order to take its proper direction of growth toward the tip of the ear (TEXT FIG. 4). Because also of this opposite arrangement of parts, the embryo develops on the abaxial side of the grain, and, in following a row, we find the alternate grains with their embryos turned toward the base of the ear, a thing that does not occur in the ordinary ear. This same pairing of the kernels with reference to the position of the embryos is noted in the pod corn that occasionally produces two grains in a pod.

An interesting suggestion as to the probable evolution of this peculiarity in this variety of sweet corn is offered by the fact that

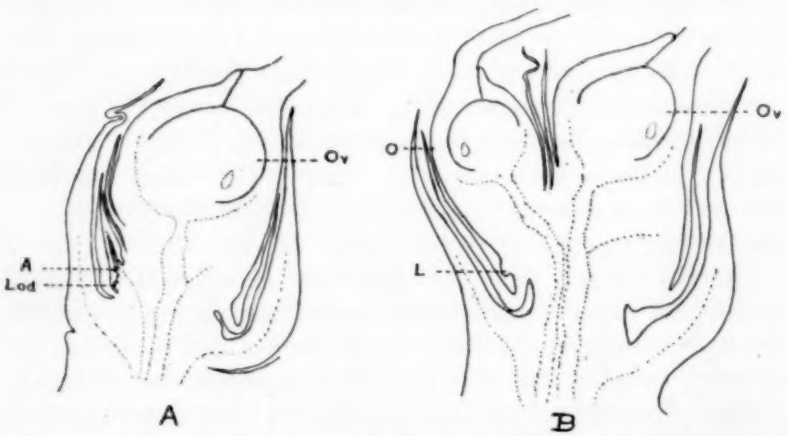

FIG. 4. Longitudinal section of female spikelet of Black Mexican sweet corn (*A*) and of Country Gentleman sweet corn (*B*). × 12. *Ov*, functional ovule; *O*, ovary that usually does not develop, except in Country Gentleman sweet corn; *A*, aborted flower; *Lod*, lodicule. (The lodicules are really lateral organs, but, when rudimentary, they are often sufficiently out of place to show in a median section.)

in the lower flower rudimentary lodicules are present as in the aborted flower of other kinds of maize. If the spikelet with two functional female flowers is the primitive one from which the other type has been developed by abortion of the lower flower, why should only one of the flowers retain its lodicules? It seems rather more probable that the second functional pistil has resulted from the development of the rudimentary one in the aborted lower flower of the typical female spikelet. In support of this belief may be added the fact that the lodicules of the functional flower

seem to be smaller and less developed than those of the aborted flower. This question will, however, bear further investigation.

POLLINATION

An unusually large number of interesting correlations are found between structure and function as applied to pollination. Practically the only means of pollen transfer are gravity and the wind. A few insects may work upon one or the other of the inflorescences, but none have been observed that find it profitable to visit both.

The most noticeable correlation, and one that sheds much light upon the probable course followed in the development of monoecism, is in the position of the male inflorescence above the female this tending to render functionless the ovaries in the tassel and the pollen in the lower inflorescence of the primitive ancestor of the maize plant.

The pollen is fine and light and easily carried by the wind. Each individual grain is smooth and dry on the outside and not well adapted to adhering to anything except something of the feathery nature of the stigma. Thus a minimum amount of pollen is lost by adhering to the leaves and stem above the female flowers.

Of course much pollen is lost by any plant that depends upon the wind for pollination, but ample allowance is made for this in maize. Lazenby's estimate for a dent variety shows that about 45,000 pollen grains are produced for every ovule; and Sargent estimates that the ratio is at least 9,000 to 1. These figures are reported by Hunt (**6**, p. 146). In a variety of popcorn that I have examined, the number of male spikelets produced is approximately the same as the number of female spikelets, the variety having an average of three ears to the stalk. But each female spikelet produces one ovule, while the six anthers of a male spikelet produce no less than 15,000 pollen grains. Since most varieties have a larger tassel and a smaller number of ears than this one, it is probable that this ratio of 15,000 pollen grains to 1 ovule is low enough.

The idea is held by many that self-pollination is prevented by the shedding of the pollen before the maturity of the stigmas

of the same plant, but such is not the case. Hunt (**6**, p. 146), Harshberger (**1**, p. 401), Collins (**15**, p. 3), and others say that self-pollination is possible, and my own observations are in accord with their conclusions. In securing pure lines for experimental work I have had occasion to self-pollenize individuals of about twenty varieties, and I have, in no case, had to have recourse to any means of pollen preservation. Contrary to the popular idea, I find that the period during which pollen is shed by any one plant extends pretty well over the time between the maturity of its first and last stigmas.

Anthesis in the male inflorescence begins a short distance from the tip of the central axis, and a little later at the tip of each rachis, and the region of maturity of the flowers passes downward along all the axes simultaneously. The period of maturity is further lengthened by the fact that the two flowers in a spikelet do not mature at the same time, and a second wave of maturity and pollen shedding follows the first. Furthermore, the anther does not discharge all its pollen as soon as it is ripe, but lets it sift out slowly. The combined effect of all these conditions is to lengthen the period over which the plant is shedding pollen.

The pistils near the base of the female inflorescence are the first to mature, and their stigmas emerge from the husk and become receptive usually about the time the first pollen is shed by the same plant. Many individuals are found, however, whose stigmas are out before the maturity of the male flowers, and the reverse is also true of many individuals. In most of the kinds commonly cultivated, however, neither of these characteristics seems to be constant for the variety. It is possible that, if the order of maturity of the two inflorescences behaves in true Mendelian fashion, this characteristic has been disregarded in hybridization and selection to such an extent that it has not become fixed for the variety. Self-pollination of an individual is rarely completely prevented in the commoner cultivated varieties by a difference in the time of maturity of the inflorescences.

But, in spite of the fact that self-pollination is possible and actually occurs to a certain extent, it is clear that cross pollination is not only the common occurrence, but is necessary for complete

pollination and the production of well-filled ears, as is shown by a comparison of the ears from isolated plants with those that have been produced where a large number of plants near together were shedding pollen at the same time.

Whether or not cross pollination is necessary for the maintenance of the full vigor of a strain is another question, and one that is by no means settled at present. It is not at all impossible that our different agricultural varieties will ultimately be found to differ in this respect. The maize varieties that we now have are the result of much haphazard hybridization, and nothing short of years of work will ever give conclusive results along this line.

FLORAL ABNORMALITIES

It has already been stated that monoecism is the rule, and that the male and female flowers are grouped together in separate inflorescences. But occasionally in probably all types, and often in at least one variety, some of the rudimentary organs are replaced by functional ones, and some usually functional are suppressed. As a result, organs of both sexes may be found in the same inflorescence in any one of three ways or in a combination of these ways:

1. Both sexes may occur in the same inflorescence but not necessarily in the same spikelet.

2. Male and female organs may be found in the same spikelet but not necessarily in the same flower.

3. The flowers may be perfect.

The first type of sex combination is very commonly observed in nearly all varieties of corn. Many writers have mentioned it, and Montgomery (**2**), especially, has published a number of illustrations of the phenomenon. Its occurrence in the tassel is apparently due to the development of the female instead of the male elements of the spikelets of one or more rachids or, more often, of the central spike. This produces a naked fructification resembling an ear, which Montgomery (**2**) makes the basis of his theory to account for the evolution of the ear. It has been noted also, as will be more fully discussed later, that some tassel spikelets in pod corn produce only female flowers. In the ear the flowers at the tip are often wholly staminate in structure, although they may never mature pollen. This transposition of sex in the ear

is known in nearly all varieties, but Kempton (**14**, p. 11) is responsible for the statement that it never occurs in pod corn. It sometimes occurs that the staminate portion of the ear is not at the tip but back some distance, as shown in FIG. 16, where the staminate portion resembles the central spike of a tassel. At least one case has been noted also where a double row of spikelets on an ear was replaced for some distance by spikelets that had the structure of those usually found in the tassel.

In the variety of pod corn that I have been growing the tassels of most plants produce female flowers, and at maturity the tassel is bent sharply downward by the weight of the fruit (FIG. 10). Kempton (**14**, p. 12) and others have noted the same, and the former observed that such plants produced no ears. The same thing was true for a number of my plants also, but most of them produced ears of the podded type. Examination of these tassels shows that many of the spikelets have one male and one female flower.

Bisexual flowers similar to the typical grass flower, except in the structure of the stigma and some minor points, have been found in both the ear and the tassel of pod corn. It is somewhat doubtful whether or not the stamens in the ear spikelets of my plants produced pollen, but they were of the normal size. In the tassel, however, both parts of the perfect flowers were most certainly functional. On account of the increased length of the glumes in these flowers, however, as in almost all flowers of this pod corn, the stamens are not exserted in anthesis. This introduces a special problem of pollination which has not yet been fully investigated.

The presence of these hermaphrodite flowers in pod corn and occasionally in other varieties, and the occurrence of both sexes in the same inflorescence but not in the same flower have provided the basis of the theory generally accepted that the monoecious flowers of the normal maize plant have developed, by the suppression of parts, from hermaphrodite flowers borne in tassel-like inflorescences by some unknown primitive ancestor.

Montgomery (**3**, p. 349) mentions an ear of dent corn that had three well-developed stamens with each grain and three small ones in the aborted flower. He says further: "This little abortive

flower can be found in the embryonic stages of development, and usually all trace of its presence is lost except the extra pair of glumes on the posterior side of the kernel. These little stamens, however, indicate that it at one time might have functioned and give us another clue to some of the evolutionary changes that this interesting plant has gone through."

Contrary to this statement, I find, as previously described, that all traces of the aborted flower are not lost but are present *in every female spikelet*, at least in rudimentary form, at the time of fecundation (FIG. 9). Moreover, if three rudimentary stamens in the spikelets of one particular ear give a clue to evolutionary changes, a much better clue must be given by the development of a normal caryopsis from the lower flower of every female spikelet of Country Gentleman sweet corn (FIG. 14).

The structure of the perfect flowers in pod corn, with reference to the order in which the four flowers of a pair of spikelets lost their staminate elements on becoming ear spikelets, has been worked out by Kempton (**14**, p. 10). He concludes that the first to change was the upper flower of the sessile spikelet, then the upper flower in the pedicelled spikelet, and then the other two flowers in the same order. Many evidences that I have observed in the tassel of pod corn are in accord with these conclusions, but an occasional spikelet with a functional ovule in the upper flower and the stamens of this one and both pistil and stamens of the lower flower aborted would lead to the belief that the entire lower flower may sometimes have become aborted without a previous loss of function by its stamens. In such spikelet, too, the lodicules of the lower flower are almost normal in appearance, while those of the upper flower are very much reduced in size. This indicates the beginning of the line of evolution that has left rudimentary lodicules in the aborted flower and entirely removed them from the upper flower of the ordinary female spikelet. Moreover, more weight must be attributed to evolutionary evidences from spikelets of the ear, which have passed through the process, than to those from tassel spikelets, which may or may not be giving indications that we are interpreting correctly.

The structure of the stamens of these tassel flowers presents a problem that cannot be solved from the standpoint of gross

morphology alone. Guided by size and shape we might select from an ordinary tassel a complete series of stamens represented at one end by a functional organ and at the other by a degree of abortion equal to that which is characteristic of the rudimentary stamens of the normal pistillate flower; and between the two extremes would be possible monstrous forms. It is only when the function of producing mature pollen has been lost that we can say that the flower has ceased to be perfect, and it is probable that, in some cases, this can be determined only cytologically or physiologically.

But the vital point of the whole question, in so far as evolution is concerned, is not the order in which the perfect flowers of a pair of tassel spikelets changed into the present pistillate condition, nor even the occurrence of occasional functional stamens or pistils in flowers of the opposite sex, but in the fact that *every flower of either sex contains either rudimentary or functional elements of the opposite sex*. This is the real indication of primitive hermaphroditism, and the other points only serve to supplement this fact.

SUMMARY

1. Normally the maize plant is monoecious.

2. The male spikelet is two-flowered. Each flower has three stamens, two lodicules, and a rudimentary pistil.

3. The female spikelet is two-flowered, but, in most instances, the lower flower is aborted.

4. In Country Gentleman sweet corn the lower flower of the female spikelet regularly functions the same as the upper one. This same phenomenon has been noted in some spikelets of pod corn.

5. The upper female flower has a pistil and three rudimentary stamens but no lodicules.

6. The lower female flower has a pistil, three rudimentary stamens, and two rudimentary lodicules, whether the flower be aborted or functional.

7. Structurally and functionally the silk is a stigma.

8. Pollination is effected by gravity and the wind. A relatively large amount of pollen is produced. Cross pollination is the more common occurrence, but self-pollination is possible and occurs to a certain extent.

9. In flowers of either sex the rudimentary organs of the opposite sex may be replaced by organs of normal appearance. In many instances these are not functional, but pistils are regularly functional in the tassels of some varieties of pod corn.

10. Except in pod corn the glumes do not enclose the caryopsis as in most grasses.

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Explanation of plates 5 and 6

PLATE 5

FIG. 1. Male spikelet of Red Cob Cory sweet corn with one flower in anthesis, × 12. *G*, glume; *Pa*, palea; *A*, anther of unopened flower; *F*, elongated filament of mature stamen; *O*, opening of anther; *J*, joint of rachilla.

FIG. 2. Male flower of Red Cob Cory sweet corn with its own palea and the other half of the spikelet removed, × 15. G, glume; *Le*, lemma; *F*, short, thick filament of immature stamen; *P*, rudimentary pistil; *Pa*, base of palea that has been removed; *L*, lodicule.

FIG. 3. Female spikelet of Red Cob Cory, × 10. *Sti*, stigma; *SC*, stylar canal; *Sty*, style; *Ov*, ovary; *G*, glumes; *J*, joint of rachilla.

FIG. 4. Female spikelet of Red Cob Cory, with floral bracts removed, × 10. *Sti*, base of stigma; *SC*, stylar canal; *Sty*, style; *Ov*, ovary (functional); *Sta*, rudimentary stamen; *P*, pistil of aborted flower; *Sta*, stamen of aborted flower; *G*, *L*, and *P*, scars left by removal of glumes, lemmae, and paleae, respectively.

FIG. 5. Tip of stigma of Red Cob Cory, showing two points and hairs for catching pollen, × 15.

FIG. 6. Adaxial side of a segment of the stigma a short distance from the style, × 15.

FIG. 7. Same as FIG. 6 but seen from the abaxial side.

FIG. 8. Transverse section of the stigma, × 30; the adaxial side is above. *V*, vascular strands; *H*, place of attachment of hairs.

FIG. 9. Aborted lower flower of female spikelet of Red Cob Cory, × 20. *Sta*, stamen; *P*, pistil; *L*, lodicule; *Pa*, palea; *Le*, scar left by removal of lemma.

PLATE 6

FIG. 10. Tassel of pod corn, bent sharply downward by the weight of the fruits that have developed in it.

FIG. 11. Pairs of spikelets from tassel of pod corn.

FIG. 12. Pairs of spikelets from ear of pod corn. One spikelet in each pair shown has two fruits.

FIG. 13. Grains of Country Gentleman sweet corn (above), and of Stowell's Evergreen (below).

FIG. 14. Ears of sweet corn. Stowell's Evergreen on the left, Country Gentleman on the right.

FIG. 15. Periodic pollination. This ear was bagged after a few silks had come out, and the bag was taken off before all the stigmas had lost their receptivity. The middle portion has no grains because the silks from this part passed their period of receptivity while the ear was protected from pollen.

FIG. 16. Ear of a yellow dent variety. The constricted place back of the tip is staminate in structure.

The Lichens of Bermuda

LINCOLN W. RIDDLE

Our knowledge of the lichens of Bermuda up to the present time has been confined to the Reports of the Challenger Expedition, based on the collections made by H. N. Moseley, who secured in Bermuda only twenty-five species and varieties of lichens. Three successive reports on the lichens of the Challenger Expedition were published. The first was that of Stirton in the Journal of the Linnaean Society for 1875 (**14**: 369–372). Two years later Crombie, with the assistance of Nylander, went over the collection, revised many of Stirton's determinations, and published a report in the journal cited (**16**: 214–217). This report included several "new species and varieties" named by Nylander, but, with one exception noted below, these differed from well-known species in chemical tests only or in such trivial characters that they cannot be considered valid. Finally, in 1885, in the official Report on the Scientific Results of the Voyage of H. M. S. Challenger, Botany, vol. 1, No. 2, Part 1, Hemsley published the list again, his list being practically a reprint of that of Crombie.

Meanwhile, in 1880 and in 1881, Professor W. G. Farlow, of Harvard University, had visited Bermuda and made a small but important collection of lichens. This was turned over to Tuckerman, who named twenty-one species, of which six were new. Tuckerman was then busy with his Synopsis of the North American Lichens and was approaching the end of his life, so that he was unable to publish descriptions of the new species that he named. Duplicates of some of these specimens were sent to the Royal Herbarium at Kew, England, and Hemsley gave a list of thirteen of these in a footnote on page 99 of his report. Descriptions of two of the new species, *Gyalecta Farlowi* and *Verrucaria bermudana*, were published by Nylander in 1890 and 1891, respectively, but the other new species from Professor Farlow's collection have remained undescribed. He has very kindly allowed me to incorporate the results of a study of his specimens in the present paper.

Between 1905 and 1914 a more complete exploration of the flora of Bermuda has been carried on by Dr. and Mrs. N. L. Britton, Dr. F. J. Seaver, and Messrs. Stewardson Brown and Paul Bisset, resulting in the finding of sixty-five species and varieties, of which fifty, including three new species, had not been previously reported.

As a result of these several collections, we now have a total of thirty-six genera, with eighty-six species and varieties of lichens, known to occur in Bermuda. Ten of these species are endemic.

The collection made by the members of the staff of the New York Botanical Garden, in coöperation with the Academy of Natural Sciences of Philadelphia, has formed the chief basis of the following enumeration. All numbers cited refer to these specimens. Since Mrs. Elizabeth G. Britton has collected more numbers than anyone else, the initials only are cited. The names of other collectors are given in full. References are also given to the species collected by Professor Farlow, and to the records of the Challenger Expedition.

1. VERRUCARIA RUPESTRIS Schrad.

On rocks, without definite station, *W. G. Farlow.*

2. VERRUCARIA RUPESTRIS var. RUDERUM DC.

Verrucaria ruderella Nyl.; Crombie, Jour. Linn. Soc. Bot. 16: 217. 1877.

On rocks, without definite station, *Challenger Expedition.*

3. **Thelidium bermudanum** (Tuck.) Riddle, comb. nov.

Verrucaria bermudana Tuck.; Nylander, Sert. Lich. trop. Labuan et Singapore 43. 1891.

As the original description is not readily accessible, it is given here: "Thallus vix ullus; apothecia pyrenio dimidiato-nigro (latit. circ. 0.25 mm.) convexa; sporae 8nae breviter fusiformes 1-septatae, long. 0.011–12, cr. 0.0035–45 mm., in thecis angustis; paraphyses graciles. Super saxa calcarea in Ins. Bermudis. Affinis *V. albido-atrae* Nyl." South shore; type collected by Professor W. G. Farlow. This species and the next are strictly maritime, growing just at tide-limit.

4. **Thelidium Farlowi** Riddle, sp. nov.

Thallus epilithicus, crustaceus tenuis vel tenuissimus continuus laevigatus plumbeus, in margine linea obscuriore cinctus. Gonidia cystococcoidea. Perithecia partim confluentia, circa 0.5 mm. diam., nigra depresso-hemisphaerica semiimmersa, strato tenuissimo thallode fere ad instar pruinae velata, apice sat late denudato; amphithecio subgloboso completo, basi tenuiore, fusconigro. Paraphyses gelatinam percurrentes. Asci 8-spori. Sporae incolores, oblongae vel ovales, biloculares, 18–20 × 7–9 μ.

On calcareous rocks, south shore, collected by Professor W. G. Farlow, 1881.

Type in the Cryptogamic Herbarium of Harvard University.

This species appears to be related to *Th. pyrenophorum* (Ach.) Koerb., but is distinct in the lead-colored thallus and the confluent perithecia, with the thin thalline covering giving a pruinose effect.

5. PORINA NUCULA Ach.

On bark of orange, Paynter's Vale, *E. G. B. 363*.

6. PORINA PHAEA (Ach.) Muell. Arg.

On *Juniperus*, Harrington House, *Stewardson Brown 560*.

7. PORINA TETRACERAE (Ach.) Muell. Arg.

On coffee trees, Walsingham, *E. G. B. 293*.

8. PYRENULA AURANTIACA Fée.

On *Rhizophora*, Fairy Land, *E. G. B. 193;* also *W. G. Farlow*, who states that it is generally common on *Rhizophora*, but very difficult to cut off.

9. PYRENULA BRACHYSPERMA Muell. Arg.

On *Eugenia*, Hall's Island, *Brown & Britton 885*.

This species was originally published in Mueller-Argau's Revisio Lichenum Eschweilerianum, Flora **67**: 670. 1884. The type came from Brazil. It is exceptional among Pyrenulas in having two-celled spores. Although there has been no material available for comparison, the Bermuda specimen agrees so well with the description that there can be no doubt of its identity.

10. PYRENULA LEUCOPLACA (Wallr.) Koerb.

On decorticated *Juniperus*, north of Hamilton, *E. G. B. 69*, on *Nerium*, Devonshire Marsh, *E. G. B. 165;* on *Rhizophora*, Fairy Land, *E. G. B. 194;* on *Eugenia*, Tucker's Town, *E. G. B. 315;* on *Ficus*, Wreck Hill, *Brown & Britton, 1108;* without definite station, *Brown, Britton & Seaver, 1225*.

11. PYRENULA MAMILLANA (Ach.) Trev.

On *Elaeodendron*, without definite station, *Brown, Britton & Seaver, 1578, 1587*.

12. PYRENULA NITIDA var. NITIDELLA (Flke.) Schaer.

On *Melia*, hillside near Flatts, *E. G. B. 50, 53;* on *Nerium*, Devonshire Marsh, *E. G. B. 164;* on trees, Church Cove, *E. G. B. 1081*. The material shows considerable variability, but on account of the small size of the perithecia appears to belong here.

13. **Anthracothecium tetraspermum** Riddle, sp. nov.

Thallus epiphloeodes crustaceus indeterminatus, sat crassus, continuus sat laevigatus aut subleprosus, olivaceus opacus. Gonidia chroolepoidea. Perithecia dispersa, 0.4 mm. diam., nigra, primum immersa et thallo obducta apice anguste denudato, demum emergentia; amphithecio globoso completo. Paraphyses simplices. Asci constanter 4-spori. Sporae fuscae oblongae murali-divisae, 4-loculares, 2-locellati, 15–20 × 8–10 μ.

On bark of palmetto, Devonshire Marsh, collected by Mrs. E. G. Britton, No. 169 in part.

Distinct from all other species of the genus in the spore-characters.

14. MELANOTHECA AGGREGATA (Fée) Muell. Arg.

On *Elaeodendron*, without definite station, *Brown, Britton & Seaver, 1583*.

15. MELANOTHECA CRUENTA (Mont.) Muell. Arg.

Without definite station, *Challenger Expedition*.

16. PYRGILLUS CUBANUS Nyl.

On bark of palmetto, Devonshire Marsh, *E. G. B. 169* in part.

An interesting species known previously only from the original collection made by Charles Wright in the island of Cuba.

17. ARTHONIA CONFERTA (Fée) Nyl.

On tamarisk, Biological Station, *E. G. B. 35;* on *Melia*, hillside near Flatts, *E. G. B. 52;* on *Melia*, Tucker's Town, *E. G. B. 866;* also, on *Melia*, Harrington Sound, *Brown & Britton, 836;* and without definite station, *W. G. Farlow.*

As was pointed out by Willey (Synopsis of the Genus *Arthonia* 12), this is the *Arthonia atrata* of the list in Hemsley's Report, but not of Fée.

18. ARTHONIA POLYMORPHA Ach.

On bark, without definite station, *Challenger Expedition*, under the name *Arthonia polymorphoides* Nyl. apud Crombie (*opus citi*), but the characters are certainly not of specific value, as they were based entirely on the chemical reactions of the hymenium.

19. ARTHONIA RUBELLA (Fée) Nyl.

On bark, Abbot's Cliff, *E. G. B. 924;* Church Cave, *E. G. B. 1082;* without definite station, *Challenger Expedition*, under the name "var. *inferiuscula* Nyl.," but the varietal characters given are not of sufficient importance.

20. ARTHOTHELIUM SPECTABILE (Flot.) Mass.

On *Elaeodendron*, without definite station, *Brown, Britton & Seaver 1585.*

21. OPEGRAPHA ATRA Pers.

On *Cocolobis*, Hungry Bay, *E. G. B. 203* in part, a small form; on *Conocarpus*, without definite station, *Brown, Britton & Seaver, 1211.*

22. OPEGRAPHA BONPLANDI Fée.

On decorticated *Juniperus*, north of Hamilton, *E. G. B. 69* in part; on *Randia*, sand hills near Paget, *E. G. B. 122;* Church Cave, *Brown & Britton, 1085;* on dead *Juniperus*, St. David's Island, *Brown, Britton & Bisset, 2080*, and on *Elaeodendron*, Abbotsford, *Brown, Britton & Bisset, 2110;* on *Juniperus*, without definite station, *Brown, Britton & Seaver, 1210, 1285.*

This species is as variable as it is common. No. 1085, with olive-brown thallus and short apothecia, is the nearest to Fée's

original figure (Essai sur les Cryptogames *pl. 5, f. 4.* 1824). In Nos. 2110, 1210, 1285, the thallus is glaucescent instead of olivaceous. In some of the specimens the spores are somewhat wider than the figures given by Mueller-Argau, but there is nothing else to distinguish these from the typical form.

23. OPEGRAPHA CHEVALIERI var. **incarnata** Riddle, var. nov.

Thallus rimuloso-areolatus, roseo-suffusus vel tandem pallescens et argillaceus.

On calcareous rocks, without definite station, collected by Professor W. G. Farlow, 1880.

Type-specimen in the Cryptogamic Herbarium of Harvard University.

24. **Opegrapha ophites** Tuck. in herb., sp. nov.

Thallus epilithicus crustaceus indeterminatus tenuissimus, atro-griseus et fuligineo tinctus, aut demum evanescens. Lirellae sat graciles elongatae, 1.0–2.5 mm. long, 0.15 mm. latit., sat flexuosae nigrae nitidiusculae simplices aut rariore furcatae laevigatae aut parce transversim diffractae, disco rimiformi. Sporae incolores, 6–8-loculares, circa 22 × 7 μ.

On calcareous rocks, without definite station, collected by Professor W. G. Farlow, 1880.

Type-specimen in the Cryptogamic Herbarium of Harvard University.

25. OPEGRAPHA VULGATA Ach.

On *Eugenia*, without definite station, *Brown, Britton & Seaver, 1288.*

26. GRAPHIS AFZELII Ach.

Without definite station, *Challenger Expedition.*

27. GRAPHIS LINEOLA Ach.

On *Melia*, hillsides near Flatts, *E. G. B. 51.*

28. GRAPHIS PAVONIANA Fée.

On *Ilex*, Devonshire Marsh, *E. G. B. 377a.*

29. GRAPHIS SCRIPTA (L.) Ach.

On *Ilex*, Devonshire Marsh, *E. G. B. 377;* without definite station, *Challenger Expedition.*

30. GRAPHIS SCRIPTA var. SERPENTINA (Ach.) Nyl.

On *Celtis*, Caves, Walsingham, *E. G. B. 291.*

31. GRAPHIS STRIATULA (Ach.) Nyl.

On *Laurocerasus*, Paget Marsh, *E. G. B. 230.*

32. PHAEOGRAPHIS LOBATA (Eschw.) Muell. Arg.

Without definite station, *Challenger Expedition.*

33. GLYPHIS CICATRICOSA Ach.

On *Celtis*, Caves, Walsingham, *E. G. B. 292*, and Church Cave, *E. G. B. 1084;* on *Elaeodendron*, Walsingham, *Brown & Britton 862;* on lemon, Jayces' Dock, *Brown, Britton & Bisset 2104;* also, without definite station, *W. G. Farlow.* Recorded in Hemsley's Report under the synonym *Gl. Achariana* Tuck.

34. CHIODECTON MONTAGNEI Tuck.?

It seems best to place here specimens of sterile thallus collected by Mrs. E. G. Britton, on *Juniperus*, Paynter's Vale, *366;* on *Elaeodendron*, Abbot's Cliff, *941;* and on rocks at Abbot's Cliff, *950.* In the absence of fruit the disposition of these specimens must remain doubtful.

35. SCLEROPHYTON ELEGANS Eschw.

On *Elaeodendron*, without definite station, *Brown, Britton & Seaver 1580.*

36. GYROSTOMUM SCYPHULIFERUM (Ach.) Fr.

On *Celtis*, Walsingham, *E. G. B. 289.*

37. **Leptotrema trypaneoides** (Nyl.) Riddle, comb. nov.

Thelotrema trypaneoides Nyl. Ann. Sci. Nat. IV. **19**: 335. 1863. Type from Cuba.

On *Elaeodendron*, without definite station, *Brown, Britton & Seaver 1581, 1588.*

38. MICROPHIALE LUTEA (Dicks.) Steiner.

On *Melia*, Tucker's Town, *E. G. B.*, a few apothecia mixed with No. 867.

39. GYALECTA FARLOWI Tuck.; Nylander, Lich. Japon. 106. 1890.

The original description reads: "Species concinna affinis *G. hyalinae* Hepp; macula thallina alba vel carneoalba, apotheciis innatis dilute carneoluteis (latit. circ. 0.25 mm.) thelotremoideis; sporae ellipsoidea murales 18–23 × 9.11 μ."

On calcareous rocks, without definite station, *W. G. Farlow*.

LECIDEA.

In the Journal of the Linnaean Society (**14**: 371. 1875), Stirton described three new species of *Lecidea*: *L. euporiza*, *L. semiusta*, and *L. revertens*. These were based on the collections of the Challenger Expedition, and are said by Crombie to be rock-specimens too fragmentary for determination. Indeed, Stirton himself says that one of these was based on a single apothecium!

40. **Biatora fuscorubescens** (Nyl.) Riddle, comb. nov.

Lecidea fuscorubescens Nyl. Bull. Soc. Linn. Norm. II. **7**: 169. 1874.

Without definite station, *Challenger Expedition*.

Said to be related to *Biatora vernalis* (L.) Fr.

41. **Bilimbia Brittoniana** Riddle, sp. nov.

Thallus epiphloeodes crustaceus indeterminatus inaequaliter crassus, omnino granuloso-leprosus, sulphureus. Gonidia cystococcoidea. Apothecia sparsa et dispersa, sat thallo occulta minuta, 0.2–0.4 mm. diam., plus minusve gyalectiformia, disco primum concavo demum plano pallide carneo, margine crasso integro persistente concolore; intus omnino incolores. Asci 8-spori. Sporae incolores fusiformes, utrinque apices obtusae, 4-loculares, 15–18 × 3 μ.

On exfoliating bark of *Juniperus*, north shore, collected by Mrs. E. G. Britton, August 31–September 20, 1905, no. 77.

This very distinct species has been named in honor of Dr. and Mrs. Britton. It is related to **Bilimbia floridana** (Tuck.) Riddle,

comb. nov., but differing in the thallus being entirely made up of sulphury granules, which under the microscope are seen to be glomerules of gonidia with a loose mixture of hyphae. The regular, marginate apothecia, resembling those of *Microphiale lutea*, also distinguish this species from *B. floridana*.

42. **Bilimbia sphaeroides** var. **vacillans** (Nyl.) Riddle, comb. nov.

Lecidea sphaeroides var. *vacillans* Nyl. Lich. Scand. 204. 1861.
Without definite station, *Brown, Britton & Seaver, 1279.*

43. BACIDIA FUSCORUBELLA (Hoffm.) Th. Fr.

On *Rhizophora*, Fairy Land, *E. G. B. 194* in part; without definite station, *W. G. Farlow.*

Agrees well with Wright's Lich. Cub. No. 220, in the Tuckerman Herbarium under the synonym *Biatora rubella* var. *spadicea* (Ach.) Tuck.

44. CLADONIA FIMBRIATA var. BORBONICA (Del.) Wainio.

On a roadside banking, Harrington House, *Brown & Britton 852.* Tropical material of the *fimbriata-pityrea* group offers an almost hopeless problem, but this specimen agrees well with Wright's Lich. Cub. No. 31, which is cited by Wainio under his account of this variety.

45. CLADONIA FIMBRIATA var. NEMOXYNA (Ach.) Coem.

According to Wainio, the specimen called "*Cl. fibula* Hoffm." in Crombie's Report belongs here. The specimen listed in the same report as "*Cl. acuminata* var. *hebescens* Nyl." is said by Wainio to be related to *Cl. fimbriata*, but not in condition for determination.

46. CLADONIA FIMBRIATA var. SIMPLEX (Weis.) Flot.

On a stone-wall near St. Mark's Church, *Brown & Britton 496; E. G. B. 1861.*

The squamules of the primary thallus are more compact than in northern material, but there seems to be nothing else to distinguish this.

47. CLADONIA MITRULA Tuck.

On the ground, Hall's Island, *E. G. B. 887* (typical); Paynter's Vale, *Brown & Britton, 980* (reduced); Paget Marsh, *E. G. B. 1862;* without definite station, *Brown, Britton & Seaver 1333;* also *Challenger Expedition.*

48. CLADONIA PITYREA (Flke.) Fr.

On the ground, growing mixed with *Cl. mitrula, Brown, Britton & Seaver, 1333* in part.

49. CLADONIA RANGIFORMIS var. PUNGENS (Ach.) Wainio.

Without definite station, *Challenger Expedition.*

50. **Psorotichia bermudana** Riddle, sp. nov.

Thallus crustaceus effusus indeterminatus crassus (0.3–0.5 mm.) diffracto-areolatus, areolis angulosis 1–2 mm. latis subdispersis, nitidus fusco-niger (madefactus atro-olivaceus), minute crebreque verruculosus vel coralloideo-granulosus; pro maxima parte hyphis tenuibus laxisque constitutis, strato exteriore tenui parenchymatico cellulis 4–10 × 4–6 μ. Gonidia gloeocapsoidea cellulis 4–6 μ diam., in glomerulosas circa 10–15 μ consociatis, tegumento gelatino fuscoluteo. Apothecia primum subimmersa demum superficialia et lecanorina, ad 0.6 mm. diam., disco inaequali fusco-nigro, margine thallino tenui granulato; intus omnino incolores. Sporae incolores simplices ellipsoideae, 14–16 × 8 μ. Spermagonia ovoidea verruculis thallinis immersa. Spermatia oblonga recta, 2–4 × 1 μ.

On calcareous rocks, without definite station, collected by Messrs. Brown, Britton & Seaver, November 29–December 14, 1912, No. 1415.

In habit this species resembles *Psorotichia diffracta* Forssell, as represented in Claudel & Harmand, Lich. Gall. Exsic. 301.

51. OMPHALARIA CUBANA Tuck.

On calcareous rocks, Castle Harbor, *Stewardson Brown 628.*

52. OMPHALARIA LINGULATA Tuck.

On calcareous rocks, Walsingham, *W. G. Farlow,* 1881; in the same region, *Brown, Britton & Seaver 2245.*

Known elsewhere from Cuba and Mona Island.

53. **Collema bermudanum** Tuck. in herb., sp. nov.

Thallus foliaceus laxe adherentis irregulariter crebre laciniatus, siccus rigidus madefactus gelatinosus, lacinulis inciso-crenatis, ad 1 mm. latis, crassiusculis planis scrabiusculis apicibus turgidis adscendentibus imbricatis, in pulvinulos constipatis 5–10 mm. diam., isidiis granulisque destitutus, superne atro-olivaceus subtus nigrescens; strato corticali destitutus. Gonidia nostocacea. Apothecia dispersa primum immersa demum subsuperficialia, ad 0.6 mm. diam., disco badio plano, margine thallino crasso integro persistente. Sporae incolores oblongae 4-loculares, 20–30 × 10–12 μ.

On calcareous rocks, Walsingham, collected by Professor W. G. Farlow, 1880.

Type-specimen in the Cryptogamic Herbarium of Harvard University.

In a letter to Professor Farlow, under date of August 25, 1881, Tuckerman wrote of this species: "*Collema* cum *C. furvo* forsan comparabile sed distincta."

54. COLLEMA FLACCIDUM Ach.

Without definite station, *Brown, Britton & Seaver 1348.*

55. COLLEMA NIGRESCENS (Huds.) Ach.

On *Avicennia*, Walsingham, *W. G. Farlow.*

56. **Collema thamnodes** Tuck. in herb., sp. nov.

Thallus fruticulosus irregulariter ramosus in pulvinulos constipatis 5–10 mm. diam., ramis erectis compressis, circa 3–5 mm. altit., 1.2 mm. latit., 0.5 mm. crassis, partim crebris isidiis, viridi-fuscus vel fusco-niger; strato corticali destitutus. Gonidia nostocacea. Apothecia ignota.

On calcareous rocks, Walsingham, collected by Professor W. G. Farlow, 1880.

Type-specimen in the Cryptogamic Herbarium of Harvard University.

57. LEPTOGIUM MARGINELLUM (Sw.) Mont.

On *Jasminium*, Paynter's Vale, *E. G. B. 368;* on *Juniperus*, without definite station, *Brown, Britton & Seaver, 1410, 1586* (beautiful specimens!).

58. LEPTOGIUM TENUISSIMUM (Dicks.) Koerb.

On the ground, Paynter's Vale, *Brown & Britton 979.*

One would scarcely expect this northern species in Bermuda, and the material being sterile the determination is not certain, but the thalline characters agree with this species.

59. LEPTOGIUM TREMELLOIDES (L. f.) S. F. Gray.

Including *L. diaphanum* (Sw.) Ach. of Crombie's Report.

There are two recognizable phases of the species in Bermuda, although these are not distinct enough to receive names. The following specimens have abundant apothecia and few lobules: on *Juniperus*, Devonshire Marsh, *E. G. B. 39;* on *Elaeodendron*, *847*, and on *Conocarpus*, Castle Harbor, *Brown & Britton 849.* The remaining specimens are sparingly fruited and have the lobes more or less densely fringed with lobules: on various trees, Walsingham, *M. A. Howe;* Castle Harbor, *846*, *848;* Hall's Island, *886*, and Paynter's Vale, *Brown & Britton 992;* St. David's Island, *Brown, Britton & Bisset, 2079.* Also collected by the Challenger Expedition.

60. PERTUSARIA LEIOPLACA (Ach.) Schaer.

P. papillata (Ach.) Nyl. of Crombie's Report.

On orange, Paynter's Vale, *E. G. B. 364;* without definite station, *W. G. Farlow;* also *Challenger Expedition.*

61. PERTUSARIA LUTESCENS (Eschw.) Krempelh. Lichenen-Flora der Südsee-Inseln, Jour. Mus. Godeffroy **1**: 104. Hamburg. 1873.

Pertusaria communis var. *lutescens* Eschw.; Martius, Flor. Bras. **1**: 118. 1833.

A complete description of the species based on several specimens, including the type, was given in Mueller-Argau's Revisio Lichenum Eschweilerianum, Flora **67**: 672. 1884.

On tamarisk, Biological Station, *E. G. B. 36* in part; and on *Melia*, hillside near Flatts, *E. G. B. 55.*

There has been no authentic specimen of this species for comparison but the material agrees well with Mueller-Argau's description cited above. The species is recorded from Rio Janeiro

and Bahia, Brazil, and from Cuba. In the Cryptogamic Herbarium of Harvard University there are specimens from the southern United States, which Tuckerman had labelled under this name with a query.

62. PERTUSARIA MULTIPUNCTA (Turn.) Nyl.

On orange, Walsingham, *E. G. B. 1;* on *Elaeodendron*, Walsingham, *Brown & Britton 863*, and Abbot's Cliff, *Brown & Britton 943*.

63. PERTUSARIA PUSTULATA (Ach.) Nyl.

On bark, Mangrove Creek, *W. G. Farlow;* without definite station, *Challenger Expedition*.

64. PERTUSARIA TUBERCULIFERA Nyl.

On *Celtis*, Walsingham, *E. G. B. 290*.

65. LECANORA BERMUDENSIS Nyl.; Crombie, Jour. Linn. Soc. Bot. **16**: 215. 1877.

Without definite station, *Challenger Expedition*.

Said to be related to *L. Hageni* Ach. I know nothing further of it.

66. LECANORA CINEREOCARNEA (Eschw.) Wainio.

Including *L. chlaronella* Nyl. of Crombie's Report.

Occurring in three well-marked forms:

Forma TYPICA, thallo crassitudine mediocre verruculoso vel verrucoso. On tamarisk, Biological Station, *37b;* on *Melia*, hillside near Flatts, *54;* on decorticated *Juniperus*, north of Hamilton, *68;* on *Rhizophora*, Fairy Land, *192* in part; on cedar posts, Paynter's Vale, *988;* all collected by Mrs. E. G. Britton.

Forma **athallina** Riddle, f. nov., thallo evanescente. On pine fence, Paynter's Vale, *E. G. B. 989, 991a*.

Forma **rugosa** Riddle, f. nov., thallo crasso rugoso. On *Melia*, west end of Causeway, *Brown & Britton, 996*.

67. LECANORA PALLIDA var. CANCRIFORMIS Tuck.

Including *L. glaucomodes* var. *conflectens* Nyl. of Crombie's Report. On *Diospyros*, Warwick Marsh, *E. G. B. 306;* without definite station, *W. G. Farlow;* also *Challenger Expedition*.

68. LECANORA SUBFUSCA (L.) Ach.

On tamarisk, Biological Station, *E. G. B. 37a;* on *Melia*, Tucker's Town, *E. G. B. 867* in part. These specimens appear to belong to the variety *allophana* Ach. In Crombie's Report, there is recorded a var. *sylvestris* Nyl. (Bull. Soc. Bot. France **15**: 188. 1868), but this is a *nomen nudum*.

69. LECANORA VARIA (Hoffm.) Ach.

On *Celtis*, Walsingham, *E. G. B. 288*.

70. LECANORA VARIA var. SYMMICTA Ach.

On *Conocarpus*, without definite station, *Brown, Britton & Seaver, 1211* in part.

71. HAEMATOMMA PUNICEUM (Ach.) Wainio.

On *Diospyros*, Warwick Marsh, *E. G. B. 307;* on *Melia*, Tucker's Town, *E. G. B. 864;* on palmetto, "the commonest habitat," without definite station, *W. G. Farlow*.

72. PARMELIA LATISSIMA var. CRISTIFERA (Tayl.) Hue.

On palmetto, North Shore Road, *E. G. B. 15*.

73. PARMELIA PERLATA (L.) Ach.

Paynter's Vale, *W. G. Farlow;* without definite station, *Challenger Expedition*.

74. PARMELIA TINCTORUM Despr.

On palmetto, Devonshire Marsh, *E. G. B. 167;* without definite station, *Challenger Expedition*.

75. RAMALINA COMPLANATA (Sw.) Ach.

On various trees and shrubs, Abbot's Cliff, *889, 934*, Fairy Land, *191*, Walsingham, *295*, Serpentine Marsh, *104*, all collected by Mrs. E. G. Britton; also, Tucker's Town, *818*, and Mangrove Pond, *1035, Brown & Britton*.

76. BUELLIA CANESCENS (Dicks.) DeNot.

On roadside wall, Devonshire, *E. G. B. 155*.

No fruit has been found so the determination cannot be

regarded as certain, but the thalline characters agree exactly with those of the species cited. As this species is entirely unknown in America, the interesting possibility suggests itself of its having been introduced into Bermuda from England, where it is common in just such habitats as the one given.

77. BUELLIA MYRIOCARPA (DC.) Mudd.

On bark of *Melia*, Tucker's Town, *E. G. B. 867* in part; without definite station, *W. G. Farlow*.

78. BUELLIA PARASEMA (Ach.) Th. Fr.

On pine-rail fence, Paynter's Vale, *Brown & Britton 991;* on *Juniperus*, St. David's Island, *Brown, Britton & Bisset 2078*.

The Bermuda material of this species varies considerably from the species as known in the northeastern United States. The thallus is either more distinctly areolate, or, in other specimens, almost absent, the disk of the apothecia is very flat, and the spores of the minimum size for the species. Yet it scarcely seems worth while giving a varietal name in the case of such a polymorphic species.

79. RINODINA INSPERATA (Nyl.) Zahlbr.; Engler & Prantl, Nat. Pflanzenfam. 1^{1*}: 232. 1907.

Without definite station, *Challenger Expedition*.

This was published originally as *Lecanora insperata* Nyl. Act. Soc. Sci. Fenn. **7**: 443. 1863. Then it was changed to *Lecidea* Nyl.; Crombie, Jour. Linn. Soc. Bot. **16**: 215. 1877. Hue, in his Lichenes Exotici (Nouv. Arch. Mus. d'Hist. Nat. Paris III. **3**: 139. 1891), places it under "Stirps *Lecideae* (*Buelliae*) *myriocarpae*." An examination of an apothecium from an original specimen in Lindig's Lich. Nov. Gran. No. 2616 shows beyond doubt that Zahlbruckner's disposition of the species is correct, in spite of the thalline exciple having disappeared.

80. BLASTENIA FLORIDANA (Tuck.) Zahlbr.

On tamarisk, Biological Station, *E. G. B. 36*, and on *Coccolobis*, north of Hamilton, *E. G. B. 66*.

81. PHYSCIA PICTA (Sw.) Nyl.

On a cliff, Paynter's Vale, *362;* on *Juniperus*, Paynter's Vale, *367;* on stone wall, Harrington House, *853;* on *Melia*, Tucker's Town, *867;* on palmetto, Devonshire Marsh, *169* in part; all collected by Mrs. E. G. Britton.

82. PHYSCIA ALBA (Fée) Muell. Arg.

A small form on *Rhizophora*, Fairy Land, *E. G. B. 192.*

83. PHYSCIA CRISPA (Pers.) Nyl.

On *Avicennia*, Serpentine Marsh, *105;* on rocks, Abbot's Cliff, *937*, *945*, 946, sterile, and *938*, fruiting; on *Celtis*, Abbot's Cliff, *947*, fruiting; all collected by Mrs. E. G. Britton; on *Juniperus*, Abbot's Cliff, *935;* on rocks, Abbot's Cliff, *939*, *940;* on *Avicennia*, west end of Causeway, *995;* all collected by Brown and Britton.

84. PHYSCIA INTEGRATA var. SOREDIOSA Wainio.

Ph. obsessa (Mont.) Nyl. of Crombie's Report.

On *Celtis*, Abbot's Cliff, *E. G. B. 923*, and on bark, Church Cave, *1080* in part, *E. G. B.*

85. PHYSCIA LEANA Tuck.

Without definite station, *Challenger Expedition.*

I give this record on the basis of Crombie's Report, not having seen the specimens, but it seems to me doubtful if the determination is correct.

86. PHYSCIA STELLARIS (L.) Nyl.

On various trees and shrubs, Biological Station, *34;* Serpentine Marsh, *106;* Tucker's Town, *865;* Abbot's Cliff, *922;* Bassett's Caves, *1040;* all collected by Mrs. E. G. Britton; also, Smith's Island, *Brown, Britton & Bisset 2102*, and without definite station, *W. G. Farlow.*

WELLESLEY COLLEGE,
WELLESLEY, MASSACHUSETTS

INDEX TO AMERICAN BOTANICAL LITERATURE

1911-1916

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in the broadest sense.

Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

This Index is reprinted monthly on cards, and furnished in this form to subscribers at the rate of one cent for each card. Selections of cards are not permitted; each subscriber must take all cards published during the term of his subscription. Correspondence relating to the card issue should be addressed to the Treasurer of the Torrey Botanical Club.

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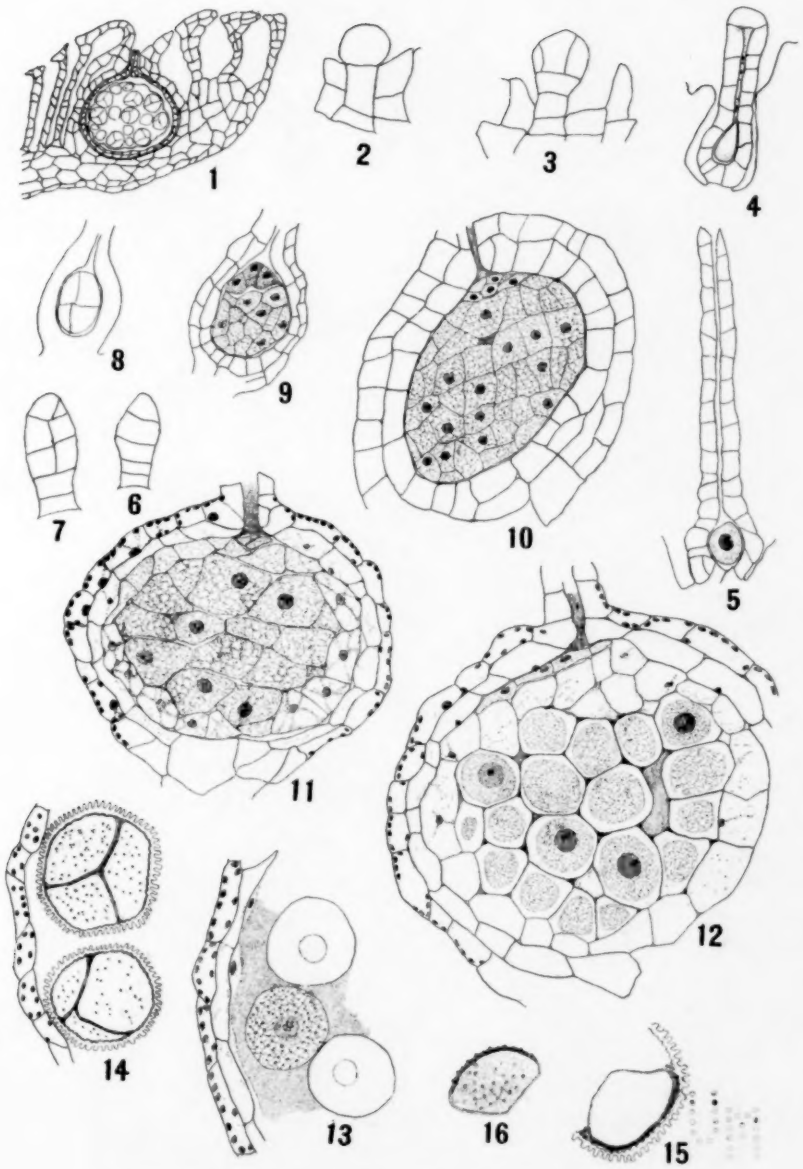

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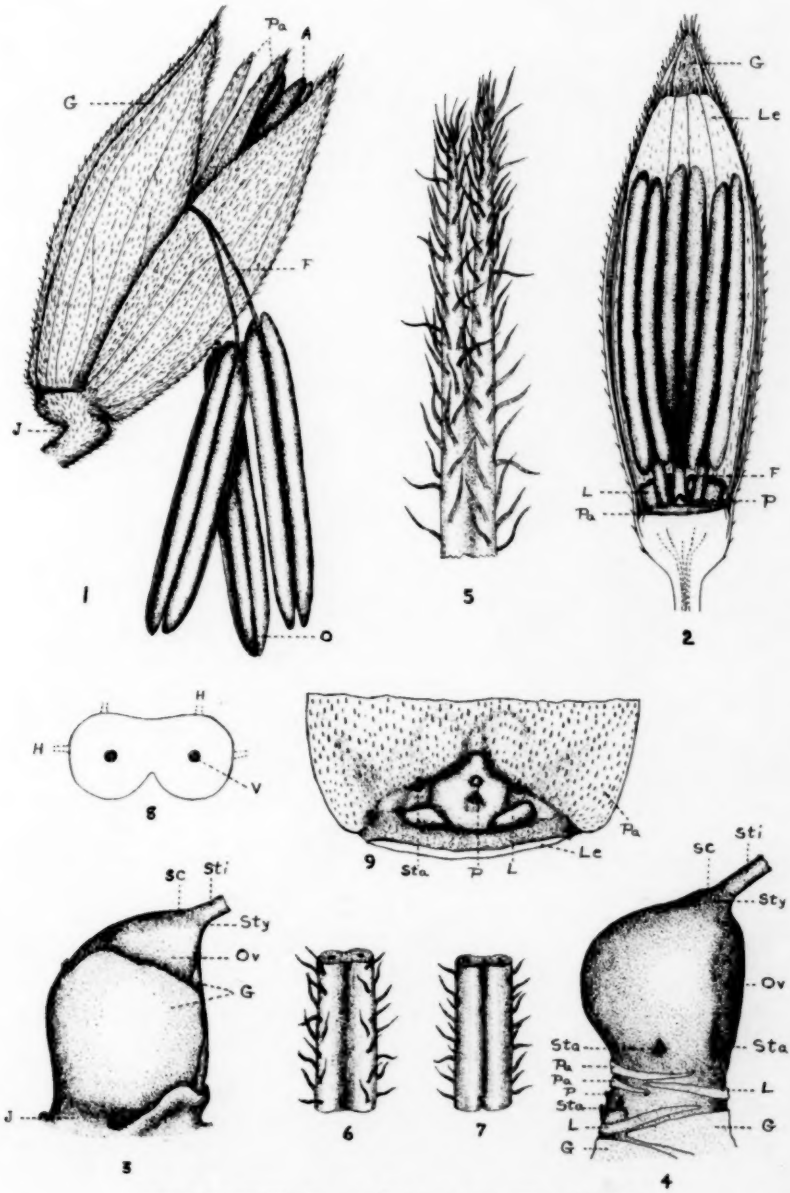

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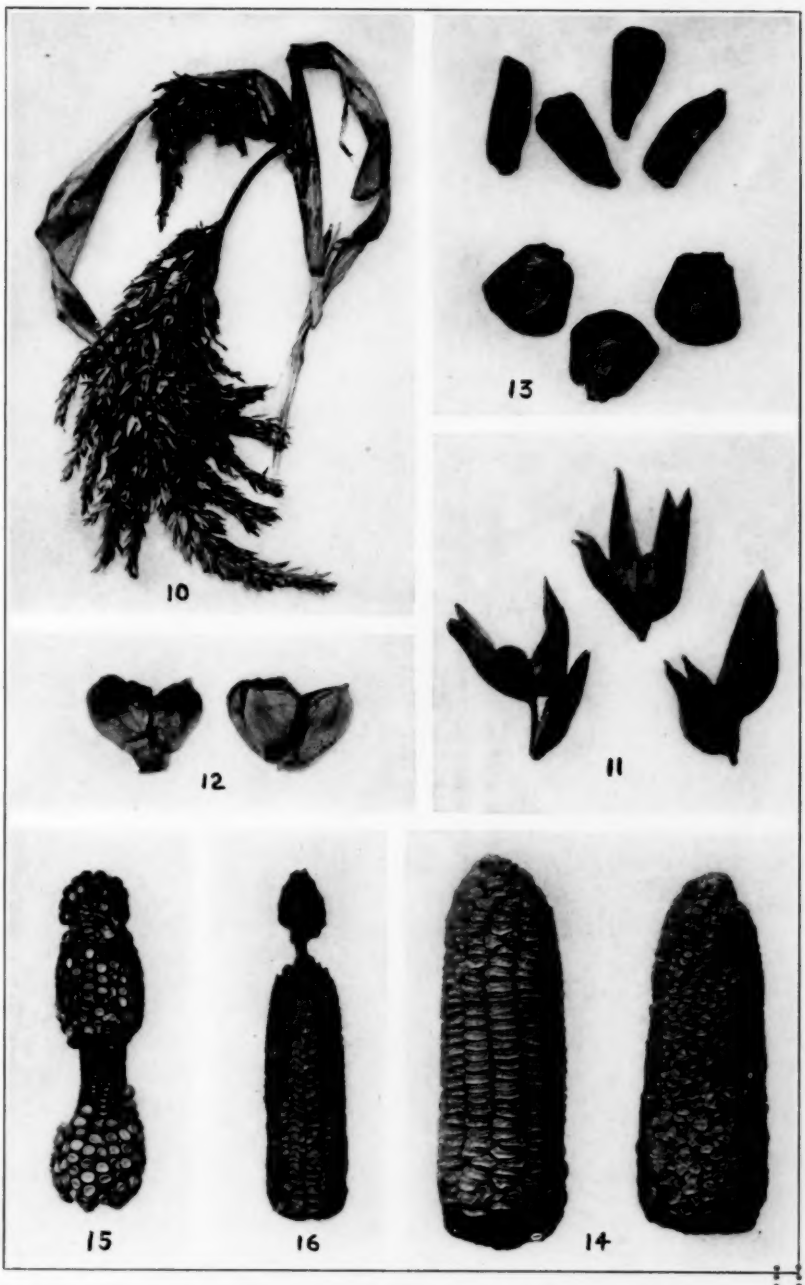

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